Informatisation in the European Union: A comparison with USA and Japan

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ABSTRACT

The term "informatisation" was coined in the sociological literature to represent the developments towards the information society or knowledge based economy. This paper determines, on the basis of a set of informatisation indicators, the extent to which the European Union (EU) countries advanced towards the information society (vis-à-vis USA and Japan) over the period leading to the single market and identifies specific clusters among the EU economies that may be distinguished as homogeneous sub-groupings. We have sought to highlight the spatial "two-tier" nature of the information society and the regional (centre-pheriphery) disparity among the EU economies, revealing the factors, other than economic, which also contributed to the North-South divide pervading the EU.

Keywords: Informatisation; Information Society; European Union; cluster analysis

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1. INTRODUCTION

Informatisation[1] refers to the process of change leading to an information based society, where the diffusion of information technology is considered critical in ensuring an inclusive information society that benefits everyone. Historically, an important facet of this process of change has been the growth of the "information sector" in the economy, coupled with the expansion of knowledge or information based occupations (Machlup, 1962; Porat, 1977; Katz, 1988). As the industrial sector in advanced economies has declined, and the services sector has grown, education, R&D, and modern technologies (e.g. computer software, electronic media, telecomunications) now occupy a greater share in the economy's output, replacing the "mental labour of men" (Masuda, 1981). These developments have led to post-industrial societies becoming more knowledge intensive, implying a transition that has been described as characteristic of an emerging information society (Bell, 1973, 1981; Touraine, 1974).

That such a transition will have important consequences for advanced economies is a proposition that is explicitly recognised by the European Union in its policy agenda.[2] Indeed, as one EU publication puts it, "The move towards an information society and the opportunities which it provides, will in the long run be as important as the first industrial revolution....The economies which are the first to succeed in completing this change will have major competitive advantages. The US and Japan are therefore attempting to speed up the process" (CEC, 1993: 95). Quite rightly, USA and Japan had recognised its importance much earlier than the EU, which only seriously began its agenda in the 1990s. In Japan, by contrast, the information society blueprint was first introduced in 1972, giving a portrait of the national plan that was to be realised by 2000 (Masuda, 1981). The main concern that this has raised is that the European countries have been lagging behind in the move towards an information society, with fears also expressed about social exclusion and the dangers of a "two-tier" information society[3].

This paper has two brief aims: first, to empirically investigate this process of informatisation in the EU economies over the period from 1970 to the early 1990s, comparing them with the progress then achieved by USA and Japan. This specific period of study is chosen to assess and evaluate those concerns about the dangers of the "two-tier" information society. Second, following Jacquemin and Sapir (1995),

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[1]Nora and Minc (1980), in their book *The Computerisation of Society,* refer to this terminology which Dordick and Wang (1993) use in defining the dimensions of the information society, drawing upon the distinction made by Kuo (1990). Griffy-Brown et al (1999) use this terminology to imply technology spillovers in production, although they indicate that information technology diffussion plays a critical role in the process

[2] The European Commission White Paper (CEC, 1993) was the first policy document that explicitly recognised the importance of the information society, although the cornerstone in the EU's policy initiative was the "Bangemann Report" (CEC, 1994).

[3] A subsequent CEC Green Paper (1996) defined the EU policy agenda, focussing on the need for widespead access to ICTs and the challenges ahead to address concerns, first raised in the Bangemann Report, about social exclusion and dangers of the two-tier society of "haves" and "haves not". Further initiatives have been made to address these concerns, the latest being the creation of the i2010 initiative, identifying challenges for the European Information Society beyond 2005 (CEC, 2005a,b)

this paper seeks to investigate, again empirically, if there existed a hard-core of EU countries during the period leading to the single market in the European Union, but in the context of the information society indicators. Thus, reflecting on the literature characterising an emerging information society, our purpose is to identify certain key indicators defined by the dimensions of the information society, on which we utilise the available data to identify specific clusters of country groupings, thereby evaluating their relative positions in the move towards the information society. Such exploratory analysis has enabled us to detect some interesting findings, and we relate these to concerns raised in the European Commission reports about the "two-tier" information society. Our statistical analysis also probes us to investigate further the trends in the data and reveal the factors underlying the regional disparity among the EU economies.

The research methodology we employ involves the use of multivariate techniques of principal components analysis and cluster analysis. Cluster analysis methodology was applied by Gidengil (1978) to test Galtung's "centre-periphery" hypothesis that imperialist powers could be distinguished from the less developed nations. Gidengil conducted her analysis on the basis of seven trade related variables, using data for 68 (developed and less developed) countries, and showed core clusters of 20 advanced countries, high on the development dimension, and 13 less developed countries, mainly Latin American, with other countries in intermediate positions between the centre and the periphery. Cluster analysis was also used with principal component analysis by Jacquemin and Sapir (1995) to investigate the hard-core hypothesis for the European Union, namely that five EU countries (Germany, France, Belgium, Luxembourg and Netherlands) represented a homogenous group that could potentially benefit from deeper integration. Their empirical analysis was conducted on the basis of twelve aggregate economic (mainly employment related) variables, using data for 12 EU members during 1992-93. Since the five countries could not emerge as a 'natural' cluster from the data, they concluded their findings by casting doubt on the credibility of the hard-core hypothesis.

The procedures for conducting principle components and cluster analysis on the data is well documented.[4] In this paper, to meet our two basic aims, we discuss the results of two experiments conducted with data comprising three groups of informatisation indicators, defined appropriately as economic, infrastructural, and social. First, the principle components and cluster analysis methodology was applied by including 15 EU member states (as of 1994), as well as USA and Japan, to determine their cluster groupings in terms of their informatisation indicators. The results clearly indicate that USA appeared at a different informatisation level, and Japan was in the same cluster group as some of the "hard-core" EU countries, while the Scandinavian countries (particularly Sweden) were further ahead in the race. Second, the empirical analysis was conducted for some years in history only for the relevant EU member states. The results refute the hard-core hypothesis but robustly confirm the centre-periphery one, as the less developed EU members appeared as a separate sub-group in contrast to the northern group of EU countries. This regional disparity has been a recognised feature

[4] In Section 3, we briefly explain the essence behind their use rather than describe the procedures. See Manly (1986) and Norusis (1993) for further details.

of the EU economies (Al-Agraa, 2004), although we highlight here its prevelance in terms of the dimensions of informatisation.

2. THE INDICATORS OF INFORMATISATION

For convenience we have defined the level of informatisation in the economy in terms of the economic, social and infrastructure dimensions, following Kuo (1990) and Dordick and Wang (1993). The list of indicators used, shown in Table 1, is partly dictated by data availability (selectively covering the period 1970-1993) and the range of representive measures then appropriately defined by the dimensions of the information society. The economic dimension may be regarded as measuring the extent of informatisation in the economy, the infrastructure dimension as characterising the diffusion of information, and the social indicators as relecting the ability of the population to assimilate the information. However, the actual distinction or the dimensions makes no difference to the empirical analysis, since it is the selection of variables that determines the clustering results.

Table 1: The Choice of Indicators[5]

Dimensions of Informatisation	Indicators
Economic	- Information workforce (% of total employment) - Educational expenditure (% of GNP) - R&D expenditure (% of GNP) - GDP per capita (PPP, US$)
Infrastructure	*Mass Media Communication* -Daily newspapers circulation (per 1000 population) -Radio licences (per 1000 population) -TV licences (per 1000 population) *Telecommunications* -Telephone main lines (per 100 population) *Computerisation* -Number of computers (per 1000 population) -Per capita ICT expenditures
Social	-Enrolment rates in tertiary education (% of 20-24 age group) -Women in Civilian Employment (% of total employment)

In the rest of this section, we provide a rationale for the indicators used. There are two main economic variables that have been used to measure the extent of informatisation in the economy: the share of the information workforce in employment and the contribution of the information sector to GNP (Machlup, 1962; Porat, 1977; OECD,

[5] The reader may consult Atik (1997) for a list of actual data and sources.

1986). Machlup's and Porat's calculation of these variables is for the US economy, and the OECD extended Porat's methodology to cover the OECD economies using disaggregated statistics from the statistical offices of the member states. In obtaining our data for the information workforce, we have avoided the difficulties inherent in the approach used by the OECD and instead followed the methodology used by Katz (1986), who employed aggregated occupational statistics from the International Standard Classification of Occupations (ICSO) to calculate the series for a range of developing countries.[6] Measuring the contribution of the information sector to GNP also involves a disaggregated approach as applied by Machlup and Porat, and the potential difficulties associated with finding disaggregated data for all the countries concerned. Thus, to avoid the problem we have used several alternative measures instead, as shown in Table 1, effectively as proxies for this variable, our choice being consistent with the argument raised by Bell (1973) that the contribution of the information sector in GNP should be based on higher education, research, and the production of knowledge as an intellectual property. Machlup, in fact, employed education and R&D (as percentage of GNP) in his calculations, and education was also considered by Porat and OECD, and by Ohira (1987) (for Japan). Machlup also considered other measures (e.g. media of communication, information machines and information services) as a basis for measuring knowledge production in GNP. Some of the information-related variables, where data has been readily available, have been included in our analysis, these being classified more appropriately as infrastructure indicators discussed below. However, as an appropriate proxy for the extent of knowledge production in the economy, we have included GDP per capita to reflect the appropriate development level of the "knowledge economy", the implicit assumption being that a higher level of economic activity is associated with a high degree of knowledge production.[7]

As for the infrastructure indicators, these have been conveniently classified into three sub-dimensions, following Kuo (1990): mass-media communication, telecommunications, and computerisation. As noted earlier, the basis for the inclusion of the infrastructure indicators is to provide a richer description of the diffusion of information in the economy, it being argued that the production, distribution and consumption of information are the main activities in an information society (Nora and Minc, 1980; Dordick and Wang, 1993). The Japanese Institute of Telecommunications and Economics (RITE) first used such measures in 1968 to construct an informatisation index for the advanced industrialised countries (Ito, 1986). We have followed Kuo (1990) by including the traditional mass-media communication measures: newspapers, radio and television. While such measures provide a network of information flow from a central point to the public at large, a

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[6] Katz used the OECD's classification as a basis for choosing the information occupations from ICSO, but had to omit some information-related occupations (suggested by the OECD) in order to make the calculation possible on readily available statistical data from the ILO's Yearbook of Labor Statistics. The discrepancies, as suggested by Katz, were relatively minor, and therefore Katz's method represents an appropriate approximation for the calculation of this variable which we employ.

[7] One could argue that GDP per head is a measure of the capacity to undertake informatisation rather than a measure of the extent of informatisation, and therefore its inclusion may be critical to our analysis. Our inclusion of this variable replaces what others have actually employed to calculate the share of the primary sector in GNP (e.g. RITE, Japan), and its exclusion from the analysis makes some difference to the clustering results but not to the overall conclusions. Below, we also highlight other factors that influence our results.

telecommunications (or electronic) network is also important for the efficient transmission of information, both for private and public communications. A primary indicator of this form of infrastructure is some measure of telephone density, such as telephone main lines per 100(0) population. Other measures include the frequency of international telephone calls and the number of telex main lines/calls (Kuo, 1990). We have included telephone main lines but excluded other measures largely due to data deficiencies.[8] The last sub-dimension in this category is computerisation, an infrastructure for electronic information processing, represented here by per capita ICT expenditures and the number of computers per 1000 population. The inclusion of these variables reflects the widespread diffusion of IT products and applications in the information society (Miles *et al*., 1990); such measures having also facilitated information transfer in other respects, via the internet for example.

The social dimension of the information society reflects the quality of the population and its ability to handle information and knowledge. This depends on the level of education and the general literacy rate (Kuo, 1990). Since professional and technical personnel make up a greater share of the information workforce in the economy, and these are classed as those having at least a university degree (Crawford, 1991), an appropriate indicator is the percentage of the population entering tertiary education. The general literacy rate (percentage of literate per 1000 population aged 10 or above) is not recorded for the industrialised countries (being regarded as almost 100%) and is therefore not appropriate for our analysis. Instead, we have included the share of women in civilian employment, reflecting their increased participation in the service economy (Bell, 1981; Crawford, 1991).[9]

3. EMPIRICAL ANALYSIS

Methodology

As explained earlier, our purpose is to establish clusters of country groupings on the basis of the above set of indicators. We therefore employ cluster analysis, the statistical technique best suited for this purpose, which enables the separation of K groups of homogenous units from a set of N>K units. Our approach has been to apply the technique to the data for a number of different years in history in order to identify whether a particular set of country groupings remains unchanged, or whether, in particular, a country moved from one cluster group to another, possibly higher group over time.

[8] Recall that our measures reflect the developments in communication up to the 1990s, and therefore measures like fax, cable and broadband connections, which have undergone rapid rise in take-ups since the 1990s, have been excluded. Another possibility excluded from our analysis is telex lines, because all countries registered almost a uniform decline in this measure, thus making no overall difference to the clustering results.

[9] One could alternatively consider some representative measure of human capital, such as the average years of secondary schooling in the economy, as more appropriate, but like the literacy rate it tends to be similar for all the countries considered, while the employment of women and its sectoral distribution tends to vary across the countries, and is more reflective of an inclusive information society.

Prior to cluster analysis, as in Jacquemin and Sapir (1995) we performed principal component analysis in order to reduce the dimensionality of the problem. Thus, instead of creating clusters of countries in a twelve-dimension space, corresponding to the twelve variables comprising the data set, we sought to work with a limited set of linear combinations of the original variables, known as principal components. In essence, the variation in the data set was represented by the first two or three principal components, accounting for at least seventy per cent of the total variance in the data.[10]

Before discussing the empirical results, it is appropriate to comment on how the cluster solutions are determined. Basically, this involves an iterative procedure, and we have used the minimum variance hierarchical method that produces a graphical tree, called a *dendogram*.[11] This method is ideal when the objective is to produce tight, homogenous groups. When the aim is to detect 'natural' groupings, however, *partitioning* methods are more appropriate (Everitt, 1974).[12] According to the hierarchical method, clusters are combined on the basis of similarity (or dissimilarity) of countries. If there are N countries, this will yield all groupings from (N-1) clusters down to 2 clusters, the solution (number of clusters) then determined by truncating at some point along the line according to some statistical criterion (indicating that highly inappropriate clusters are being combined from that point on). As Jacquemin and Sapir (1995) explain, a visual inspection of the dendogram reveals such a solution by moving an imaginary vertical line from right to left until the truncation point, the separate branches at that point yielding the cluster groupings.

Results

As explained in the introduction, we considered two sets of experiments with the objective of dermining, first, the country grouping for the 15 EU countries (EU-15) relative to USA and Japan, and, second, the associated sub-groupings to identify the hard-core among the EU countries only. Table 2 reports the clustering results for the first exercise just for the years just for the years 1970, 1980 and 1991, as these reveal some interesting anomalies as well as similarities, although we conducted our analysis for a number of different years spanning the period 1970-1993.[13] The clustering experiment for the pre-1990 years was actually carried out with ten variables rather than twelve, as the data for computer numbers and per capita ICT expenditures were not available before 1991. However, results for 1991 are reported with both ten and twelve variables to ensure consistency. The country dimension for this exercise was the same throughout (i.e. US, Japan and EU-15), although as we report below the

[10] The criterion used to determine the number of principal components was based on the number of eigenvalues of the matrix of 'data moments' exceeding unity, and selecting the corresponding matrix of eigenvectors (principal components) which, upon pre-multiplication by the data matrix, yields the appropriate matrix of principal components *scores* used for cluster analysis (see e.g. Manly, 1986).

[11] A 'complete linkage' clustering method has been chosen to produce dendograms as it is the most widely used (Norusis, 1993: p.97). The Appendix shows a sample of dendograms for the results obtained.

[12] Gidengil (1978) employed a *partitioning* method to detect 'natural' clusterings using 'mode analysis', where searching for high-density regions in the data (modes) forms clusters.

[13]Results for the other years support our broad conclusions, subject to the proviso that sub-groups of clusters tend to emerge as the arbitrary point of truncation is extended further towards the left on the dengogram.

results did not differ with Luxemberg dropped from the analysis (as it turned out to be an outlier in most cases).

Table 2: Clusters Groupings (17 countries: EU15, USA and Japan)

1970				
USA	Austria, Belgium, Denmark, Finland, France, Germany, Japan, Luxembourg, Netherlands, Sweden, UK	Greece, Ireland, Italy, Portugal, Spain		
1980				
USA	Sweden	Austria, Belgium, Denmark, Finland, France, Germany, Italy, Japan, Luxembourg, Netherlands, UK	Greece, Ireland, Portugal, Spain	
1991	**(10 variables)**			
USA	Denmark, Finland, Sweden	Austria, Belgium, France, Germany, Japan, Luxembourg, Netherlands, UK	Greece, Ireland, Portugal, Spain	Italy
1991	**(12 variables)**			
USA	Sweden	Austria, Belgium, Denmark, Finland, France, Germany, Japan, Netherlands, UK	Greece, Ireland, Italy, Portugal, Spain	

The clustering results shown in Table 2 confirm a number of overall conclusions. Firstly, the US was consistently ahead from the rest of the EU-15 and Japan, reflecting its superiority on most of the measures considered particularly the economic and social ones. For example, its GDP per capita and its share of employment in information occupations, as well as its investment in higher education (determined by the enrolment rate in tertiary education) are consistently higher than the rest of the group. Secondly, among the rest of the countries, we can identify two groups of countries: a “northern” group (comprising Japan, Germany, France, UK, Belgium, Netherlands, Luxembourg, Denmark, Sweden, Finland and Austria) and a “southern” or periphery group (Ireland, Portugal, Spain and Greece), with Italy switching positions between the two or placed “in between”. Finally, among the “northern” group of countries, it is also possible to distinguish two further groupings, a “central” group (comprising Japan, Germany, France, UK, Belgium and Netherlands) and the Scandinavian countries (Denmark, Finland, Sweden), although other cluster combinations also emerged.[14]

[14] Austria, for some years (not shown), has switched sides, belonging to the Scandinavian group, while Luxembourg appeared as an ‘outlier’ on its own. The latter was therefore dropped from the twelve variable analyses of 1991 and 1992.

These findings reveal some interesting anomalies. For example, Japan, despite its early agenda and superior record of economic performance, remained entrenched with the "central" group of EU economies. A cursory inspection of the data reveals that its expenditure on R&D matched that of US, but on most other measures it resembled the EU economies of the "central" group. Interestingly, the Scandinavian countries fared better than others on some measures, particularly with regard to educational expenditure and telephone main lines, as shown in Figures 1 and 2.

Sweden, in particular, had advanced further towards the US than other countries.[15] Most notably, Sweden distinguishes itself from the rest of the northern group in 1991 when ICT expenditures and computers are introduced as additional measures. Results for other years (e.g. 1992 and 1993) have confirmed a picture of the Scandinavian countries "catching up" with the US faster than other countries.[16]

In order to reduce the degree of heterogeneity possibly created by the number of countries chosen, and to identify possible hard-core of countries among the former EU members, in the second experiment we sought to establish country groupings by considering only the relevant EU members states (i.e. excluding US, Japan and the post-1994 EU members – namely Sweden, Finland and Austria). Table 3 shows three cluster solutions for the years 1988, 1992 and 1993, confirming Luxembourg's intermediate position between the two core-periphery clusters. In this sense, the results reject the hard-core hypothesis for the EU but confirm the North-South rift prevailing in the EU, with Italy in a somewhat intermediate position switching between the two clusters.

Table 3: Cluster Groupings (EU12: pre-1994 members)

1988		
Belgium, Denmark, France, Germany, Italy, UK	Luxembourg	Greece, Ireland, Portugal,Spain
1989, 1993		
Belgium, Denmark, France, Germany, UK	Luxembourg	Greece, Ireland, Italy, Portugal, Spain

The North-South rift and the perculiar finding of Italy's position in the EU is also confirmed by Jacqueman and Sapir (1995). In our case, a possible explanation for Italy's position is the comparatively lower shares of the information workforce and per capita ICT expenditures. Figure 3 shows the discrepancies in the trends of ICT expenditures in the 1990s, confirming Italy's weaker position. Thus, despite its industrial base, Italy appeared slow on the take-off towards the information society.

[15] As can be observed from the dendogram for 1980, an arbitrary truncation of the solution earlier than shown would classify Sweden in the same cluster group as the US, although we have classified it separately.
[16] The Appendix actually shows dendograms for 1970, 1980, 1991 and 1992 exhibiting this outcome (the latter two with 12 variables but without Luxemberg as it represented an outlier in this case).

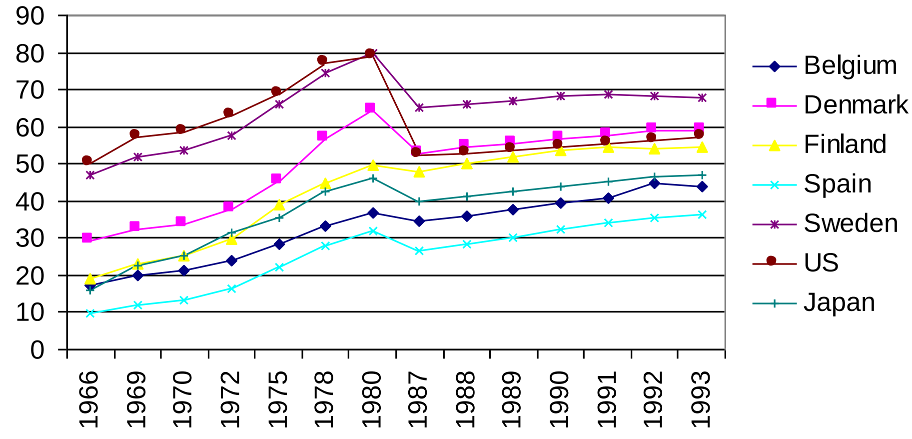

Figure **Telephone Main Lines (per 1000)**

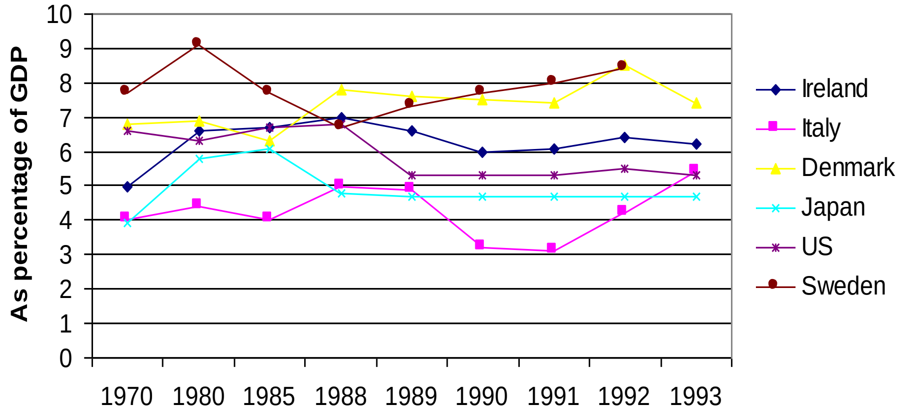

Figure **Educational Expenditure (1970-1993)**

	Figure	.991	1992	1993	1994	1995
	Irelaı	4.43	4.26	4.8	4.63	4.56
	Italy	2.53	2.48	3.13	3.21	3.18
	Sweden	4.16	4.03	5.7	5.83	6
	UK	4.72	4.52	5.23	5.23	5.32
	US	5.68	5.65	5.63	5.63	5.71
	Japan	4.37	4.15	3.62	3.49	3.66

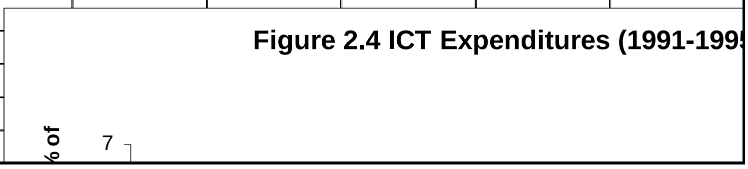

Figure 2.4 ICT Expenditures (1991-199

5. Conclusion

Monitoring the process of change towards the information society, by exploratory data analysis and trends, over the period conciding with the developments leading to the single market in the EU has revealed that the regions of Northern Europe seem to have adjusted more favourably than the South (to include Ireland), confirming the North-South distinction which matters for convergence (Neven and Gouyette, 1994). This paper has also studied the position of the US and Japan in relation to the EU, finding the position of the US well ahead in the race with Japan even behind the Scandinavian countries (Sweden in particular), along with other northern EU states. The results also refute the hard-core hypothesis for the EU implying that 5 EU countries, namely France, Germany and the three Benelux countires, represented a “natural” cluster benefiting from deeper integration in the EU.

How do we interpret the practical importance of our findings? Recent EU initiatives and documents (op cit) have drawn attention to the importance of creating a European Information Space to alleviate the structural and regional differences among the EU states raise some special concerns for the EU authorities in their attempts to move the European nations forward towards the information society. If all regions of the EU will not have access to the same technologies, then the positive impact of the information society on economic development will be undermined by the greater inequality that it will create between the richer and the poorer regions of the EU. This danger, however, is different, although related, from the “two-tier” nature of the information society that results from social exclusion of the under-privileged (CEC, 1996). Our finding confirms the “two tier” nature of the EU in a spatial sense, highlighting the broad nature of the disparity between the North and the South.

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